

CLAIMS

We claim:

1. A method for automatically generating a fully-textured 3D model of an object; said method comprising:
 - receiving from a camera a sequence of images taken sequentially and respectively around the object;
 - generating a 3D region from a sequence of mask images; each of said mask images derived from one of said sequence of images;
 - generating a mesh model from said 3D region using a tree structure; and
 - producing said fully-textured 3D model from said mesh model with respect to said sequence of images.
2. The method as recited in claim 1 further comprising:
 - receiving a reference image captured when a calibration target is in the place of said object; and
 - deriving a camera model of said camera from said reference image.
3. The method as recited in claim 2, wherein said calibration target is of round shape and has a center thereof, and wherein said reference image covers only a portion of said calibration target, said portion including said center.

4. The method as recited in claim 3, wherein said deriving a camera model comprises:

detecting said center from said reference image and a pair of
 end points having a maximum distance, horizontally and
 vertically, respectively, from said center; and
 calculating a major axis and a minor axis extending from
 said center to said pair of end points, respectively.

5. The method as recited in claim 1, wherein said generating a 3D region comprises:

utilizing cubes representing said object; and
 carving said cubes recursively to fit said object by projecting
 said cubes against each of said mask images.

6. The method as recited in claim 5; wherein each of said cubes is encoded as a node in said tree structure that grows, while said carving said cubes recursively proceeds, till a predefined degree of refinement.

7. The method as recited in claim 6; wherein said generating a mesh model comprises:

collecting all leaves of said tree structure by traversing said
 tree structure,
 determining boundary cubes from said leaves; and

triangulating a group of at least three of said boundary cubes
according to predefined rules.

8. The method as recited in claim 7, wherein said mesh model is
described by a plurality of triangles, each connecting three of
said boundary cubes.

9. The method as recited in claim 8, wherein said producing said
fully-textured 3D model comprises:

assigning each of said triangles to one of said images
according to a normal of said each of said triangles; and
texturing said each of said triangles with respect to said one
of said images.

10. The method as recited in claim 8, wherein said producing said
fully-textured 3D model comprises:

growing patches respectively by adding each of said
triangles to one of said patches when said each of said
triangles shares at least one edge with entered triangles
in said one of said patches; and
providing said patches for editing by a user using an image
editing application.

11. The method as recited in claim 1, wherein said object is placed on a routable platform so that said sequence of images are taken when said object is rotated.

5 12. The method as recited in claim 11, wherein said routable platform is driven by a stepper motor controlled by a computing device that synchronizes said camera so that each of said images is taken at a known position.

10 13. The method as recited in claim 1; wherein said sequence of images are taken when said camera is moved around said object.

15 14. The method as recited in claim 13; wherein each of said images is taken at a known position by said camera.

20 15. A method for automatically generating a fully-textured 3D model of an object; said method comprising:

receiving from an camera a reference image of a portion of a calibration target having a center for deriving a camera model of said camera; said portion including said center; detecting said center from said reference image and a pair of end points having a maximum distance, horizontally and vertically, respectively, from said center; and

calculating a major axis and a minor axis extending from said center to said pair of end points, respectively.

16. The method as recited in claim 15, further comprising:

receiving from said camera a sequence of images taken sequentially and respectively around the object; and converting said sequence of images respectively and correspondingly to a sequence of mask images.

17. The method as recited in claim 16, further comprising:

generating a 3D region from said mask images; generating a mesh model from said 3D region using a tree structure; and producing said fully-textured 3D model from said mesh model with respect to said sequence of images along with said camera model.

18. A computer readable medium for storing computer program instructions for automatically generating a fully-textured 3D model of an object; said computer readable medium comprising: first program code for receiving from a camera a sequence of images taken sequentially and respectively around the object;

second program code for generating a 3D region from a
sequence of mask images; each of said mask images
derived from one of said sequence of images;
third program code for generating a mesh model from
said 3D region using a tree structure; and
5 fourth program code for producing said fully-textured 3D
model from said mesh model with respect to said
sequence of images.

10 19. The computer readable medium as recited in claim 18 further
comprising:
fifth program code for receiving a reference image
captured when a calibration target is in the place of said
object; and
15 sixth program code for deriving a camera model of said
camera from said reference image.

20 20. The computer readable medium as recited in claim 19, wherein
said calibration target is of round shape and has a center
thereof, and wherein said reference image covers only a portion
of said calibration target, said portion including said center.

21. The computer readable medium as recited in claim 20, wherein
said sixth program code comprises:

program code for detecting said center from said
 reference image and a pair of end points having a
 maximum distance, horizontally and vertically,
 respectively, from said center; and
 program code for calculating a major axis and a minor axis
 extending from said center to said pair of end points,
 respectively.

22. The computer readable medium as recited in claim 18, wherein
 said second program code comprises:

program code for utilizing cubes representing said object;
 and
 program code for carving said cubes recursively to fit said
 object by projecting said cubes against each of said
 mask images.

23. The computer readable medium as recited in claim 22; wherein
 each of said cubes is encoded as a node in said tree structure
 that grows till a predefined degree of refinement.

24. The computer readable medium as recited in claim 23; wherein
 said third program code comprises:
 program code for collecting all leaves of said tree structure
 by traversing said tree structure,

program code for determining boundary cubes from said
 leaves; and
 program code for triangulating a group of at least three of
 said boundary cubes according to predefined rules.

5

25. The computer readable medium as recited in claim 24, wherein
 said mesh model is described by a plurality of triangles, each
 connecting three of said boundary cubes.

10

26. The computer readable medium as recited in claim 25, wherein
 said fourth program code comprises:

program code for assigning each of said triangles to one
 of said images according to a normal of said each of said
 triangles; and

15

program code for texturing said each of said triangles with
 respect to said one of said images.

27. The computer readable medium as recited in claim 25, wherein
 said fourth program code comprises:

20

program code for growing patches respectively by adding
 each of said triangles to one of said patches when said
 each of said triangles shares exactly one edge with
 entered triangles in said one of said patches; and
 program code for providing said patches for editing by a
 user using an image editing application.

25

28. The computer readable medium as recited in claim 18, wherein said object is placed on a routable platform so that said sequence of images are taken when said object is rotated.

5

29. The computer readable medium as recited in claim 28, wherein said routable platform is driven by a stepper motor controlled by a computing device that synchronizes said camera so that each of said images is taken at a known position.

10

30. The computer readable medium as recited in claim 18; wherein said sequence of images are taken when said camera is moved around said object.

15

31. The computer readable medium as recited in claim 30; wherein each of said images is taken at a known position by said camera.

20

32. A computer readable medium for automatically generating a fully-textured 3D model of an object; said computer readable medium comprising:

program code for receiving from an camera a reference image of a portion of a calibration target having a center for deriving a camera model of said camera; said portion including said center;

25

program code detecting said center from said reference
image and a pair of end points having a maximum
distance, horizontally and vertically, respectively, from
said center; and

5 program code calculating a major axis and a minor axis
extending from said center to said pair of end points,
respectively.

33. The computer readable medium as recited in claim 32, further
comprising:

10 program code for receiving from said camera a sequence of
images taken sequentially and respectively around the
object; and

15 program code for converting said sequence of images
respectively and correspondingly to a sequence of mask
images.

34. The computer readable medium as recited in claim 33, further
comprising:

20 program code for generating a 3D region from said mask
images;

program code for generating a mesh model from said 3D
region using a tree structure; and

Corel
D10

program code for producing said fully-textured 3D model
from said mesh model with respect to said sequence of
images along with said camera model.

Sub
CB

5 35. A system for automatically generating a fully-textured 3D model
of an object; said system comprising:

a turntable driven by a stepper motor to rotate said object
placed thereon;

10 a camera positioned within a field of view of said camera
viewing from an angle • looking down toward, and
slightly oblique to said turntable;

15 a computing device including memory loaded with program
code, said computing device coupled to and
synchronizing said camera and said stepper motor, said
computing device caused, when said program is
executed therein, to perform operations of:

receiving from said camera a sequence of images
taken sequentially and respectively of said object
when said object is being rotated by said stepper
20 motor;

generating a 3D region from a sequence of mask
images; each of said mask images derived from
one of said sequence of images;

25 generating a mesh model from said 3D region using a
tree structure; and

producing said fully-textured 3D model from said
mesh model with respect to said sequence of
images.

5 36. The system as recited in claim 35, wherein said memory is
further loaded with an image processing application.

37. The system as recited in claim 36, wherein said producing said
fully-textured 3D model comprises:

generating textured patches covering said object; and
exporting said textured patches to said image processing
application for being edited and modified by a user.

38. The method as recited in claim 37, wherein said producing said
fully-textured 3D model further comprises:

combining said edited and modified textured patches to
represent said fully-textured 3D model in a desired
manner by the user.